

# FNAL/BNL study status

## 8/16/2006

BNL director's meeting.  
Milind Diwan

# Study charge

- 1. A broad-band proposal using a either an upgraded beam of around 1 MW from the current Fermilab accelerator complex or a future Fermilab Proton Driver neutrino beam aimed at a DUSEL-based detector. Compare these results with those previously obtained for a high intensity beam from BNL to DUSEL.
- 2. Off-Axis next generation options using a 1-2 MW neutrino beam from Fermilab and a liquid argon detector at either DUSEL or as a second detector for the Nova experiment.

Considerations of each should include:

i) As a function of  $q_{13}$ , the ability to establish a finite  $q_{13}$ , determine the mass hierarchy, and search for CP violation and, for each measurement, the limiting systematic uncertainties.

ii) The precision with which each of the oscillation parameters can be measured and the ability to therefore discriminate between neutrino mass models.

iii) Experiment Design Concepts including:

Optimum proton beam energy

Optimum geometries

Detector Technology

Cost Guesstimate

# Who is involved ?

- There are 82 participants
- From the names, almost all have participated at some level.
- Meetings have been generally well attended.

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# List

# Key workers

- Bonnie, Finley, Pordes, Menary on LAR, offaxis. Curioni at Yale is doing MC studies.
- Our group: Mary, Brett, Christine, Jordan, Mark, Milind + others
- Simos, Harold contributed to target document and simulations.
- Patrick Huber, Danny Marfatia sensitivity paper
- Ken Lande + Al from Penn wrote the detector document.
- Marchionni + Zwaska: proton power
- Bogert+Smart: beam to DUSEL
- Rameika + postdoc on off axis rates.

# Meetings

- Look at
  - <http://nwg.phy.bnl.gov/~diwan/nwg/fnal-bnl>
- March 5-6, 2006: kick off
- Nusag presentations: May 20, 2006
- June 27-28: midterm workshop
- Sep 16-17: next meeting
- Mont indicated that he would like another meeting.
- Report due in October. NUSAG report due in December.

# Summary of work I

- Proton power 0.5 MW @ 50 GeV and 1 MW @ 120 GeV possible at FNAL with ~\$30-50M upgrades.
- New beamline to DUSEL possible at FNAL @same cost as NUMI (\$70M(FY2002)).
- New beamline should be 4 m diameter, ~300-400 m long.
- Rates with 1 MW are ~ 10000 to 25000 events/yr/100kT depending on  $E_p$ , 1300 km.

# Summary of work II

- 300 kT @ HStake will cost ~\$300M at 5-6 yrs, but much more work needed.
- Off axis rates have been agreed to for 1MW (5.2e20 pot @ 120 GeV for  $10^7$  sec)
  - ~9000 evts/100kT/yr at 12 mrad, 810km
  - ~447 evts/100kT/yr at 40 mrad 810km



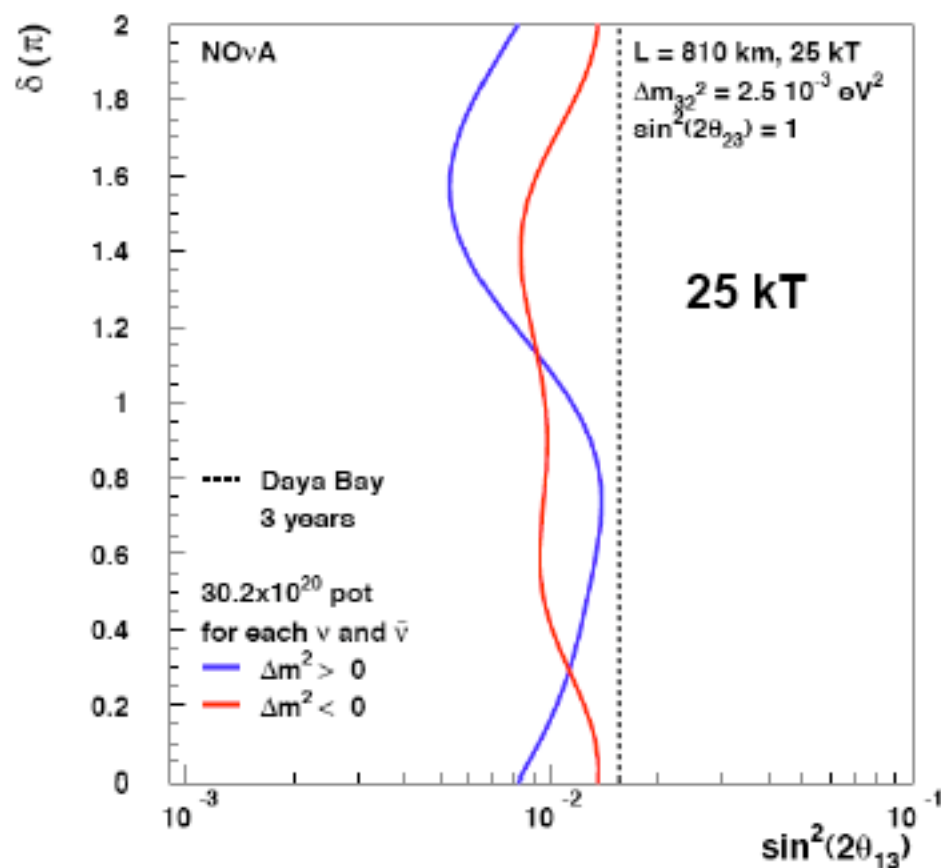
# LAR work

- No technical work on LAR has been written up. Depth issue has been argued out and looks like the answer is ~50 meters is good for LAR.
- Very little analysis with LAR MC has been reported (Curioni). Conclusion: LAR has perhaps ~3 advantage in background.
- Sensitivity analysis with off-axis not reported. But see next plots.

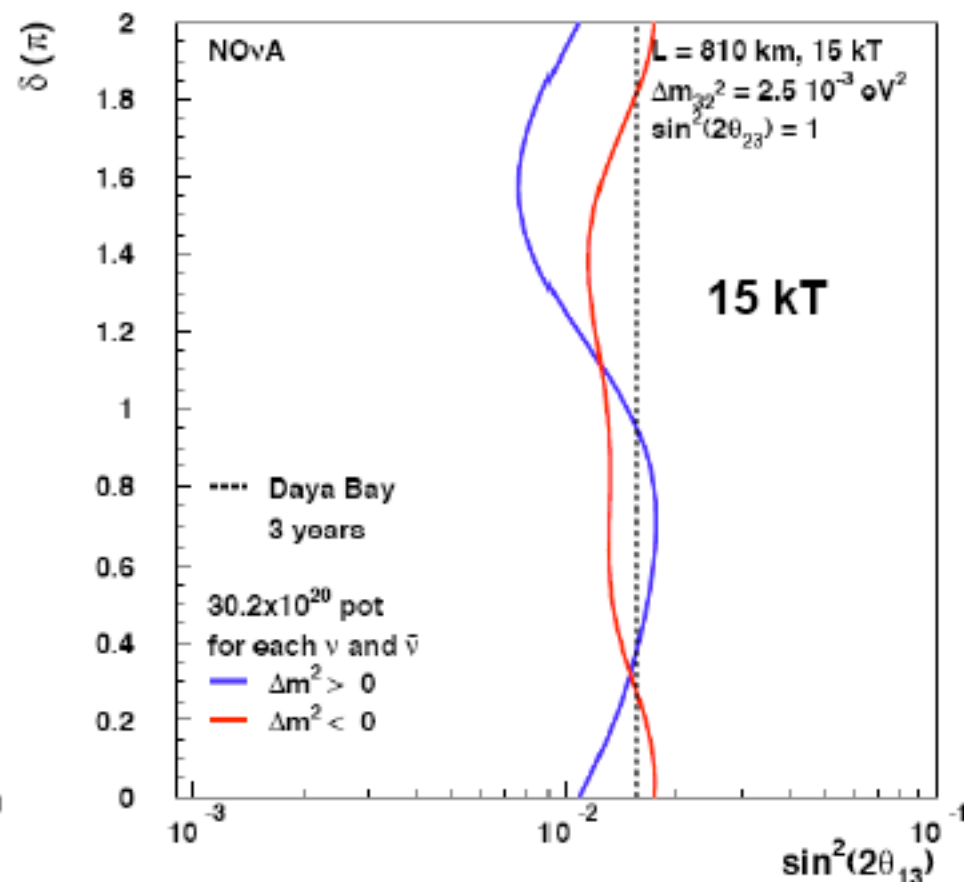


# Comparison of 25 kT and 15 kT

3  $\sigma$  Sensitivity to  $\sin^2(2\theta_{13}) \neq 0$



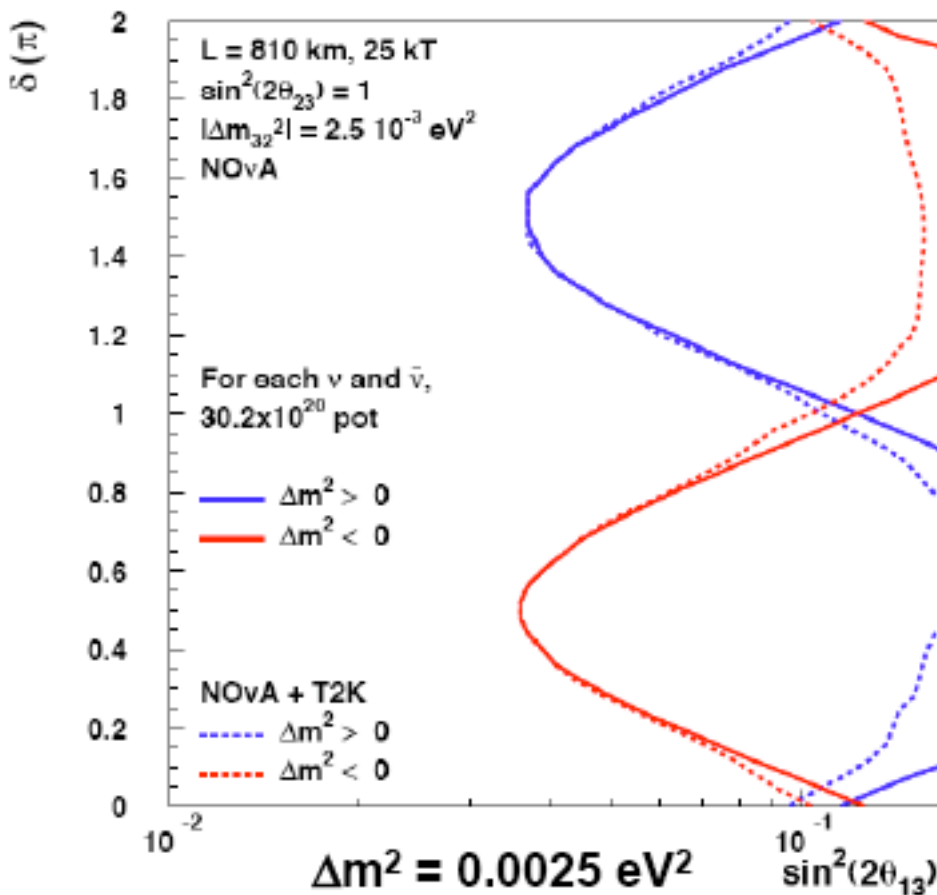
3  $\sigma$  Sensitivity to  $\sin^2(2\theta_{13}) \neq 0$



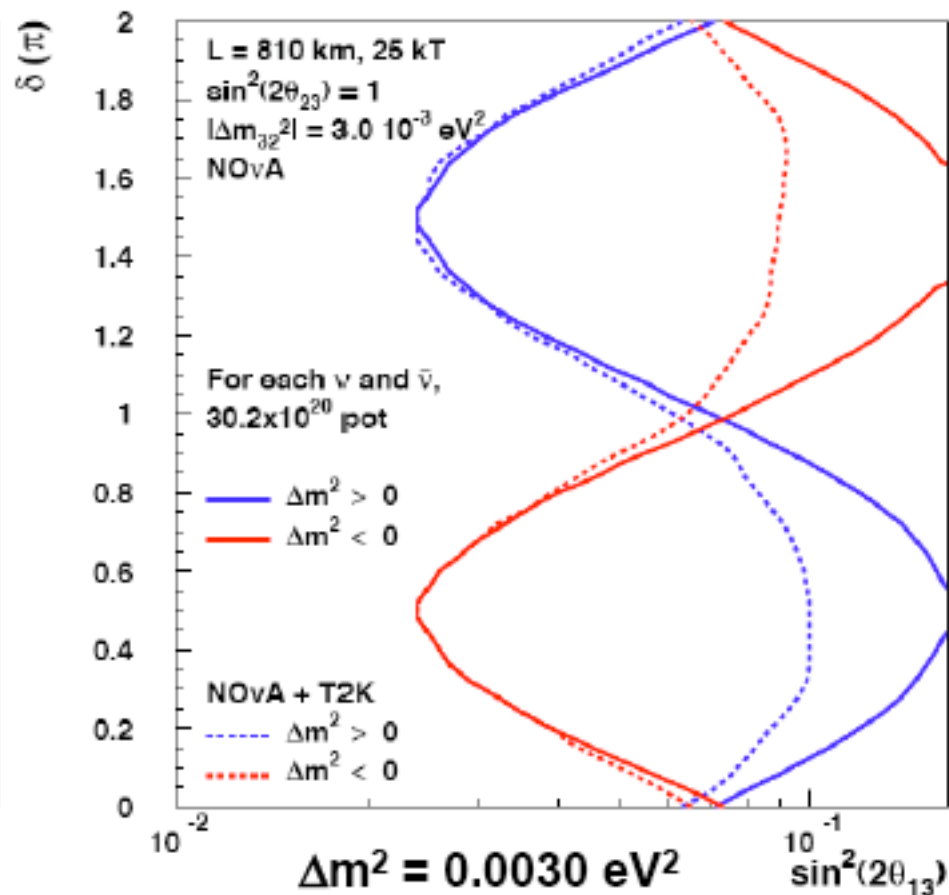


# Combining NOvA and T2K

95% CL Resolution of the Mass Hierarchy



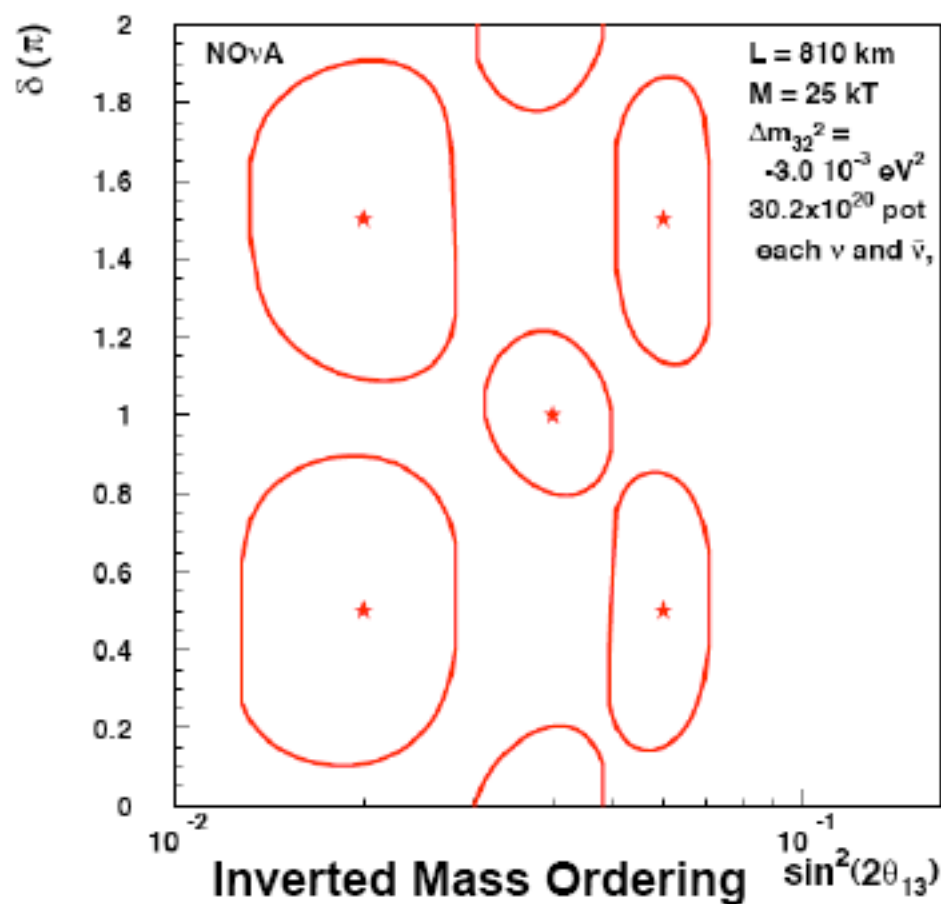
95% CL Resolution of the Mass Hierarchy



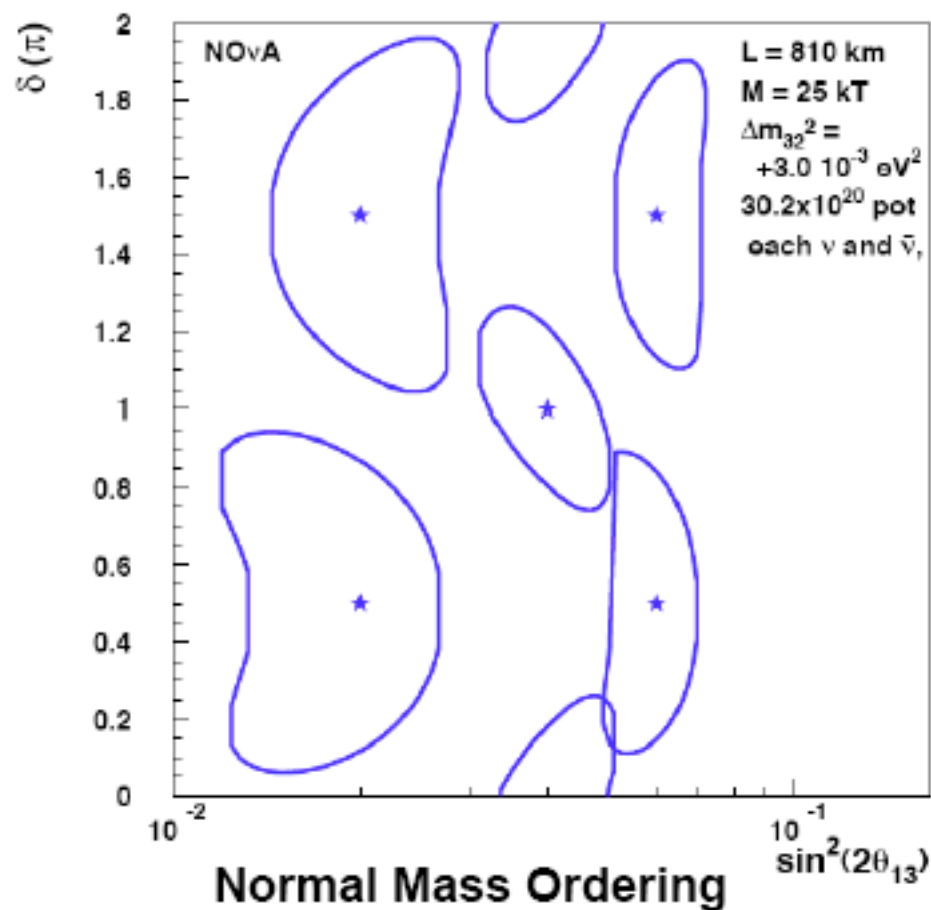


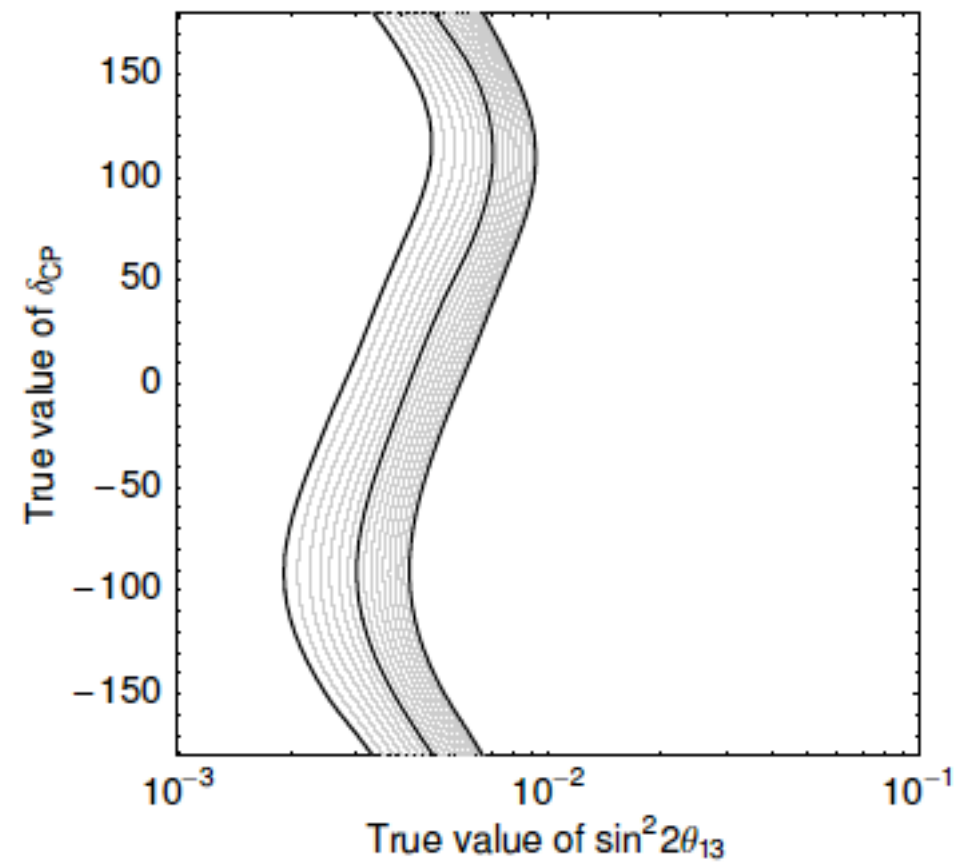
# $\delta$ vs. $\sin^2(2\theta_{13})$ Contours: Normal vs. Inverted Mass

1  $\sigma$  Contours for Starred Points



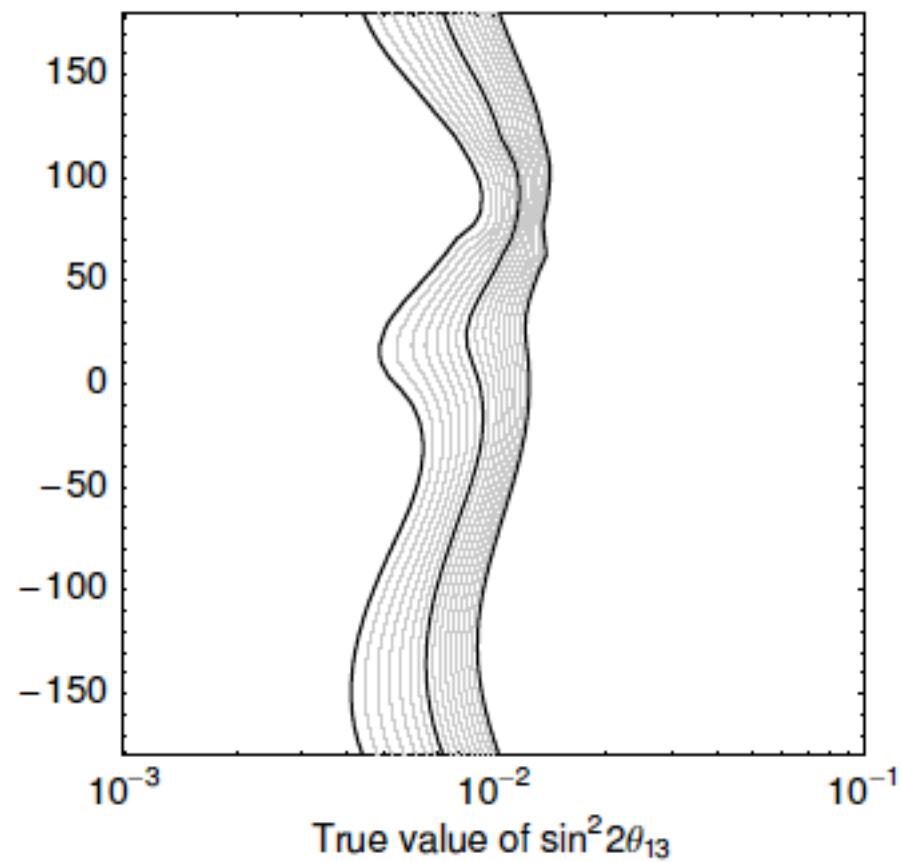
1  $\sigma$  Contours for Starred Points





discovery of  $\theta_{13}$

WBLE 1300 km



Discovery potential for a normal mass hierarchy at a baseline of 1300

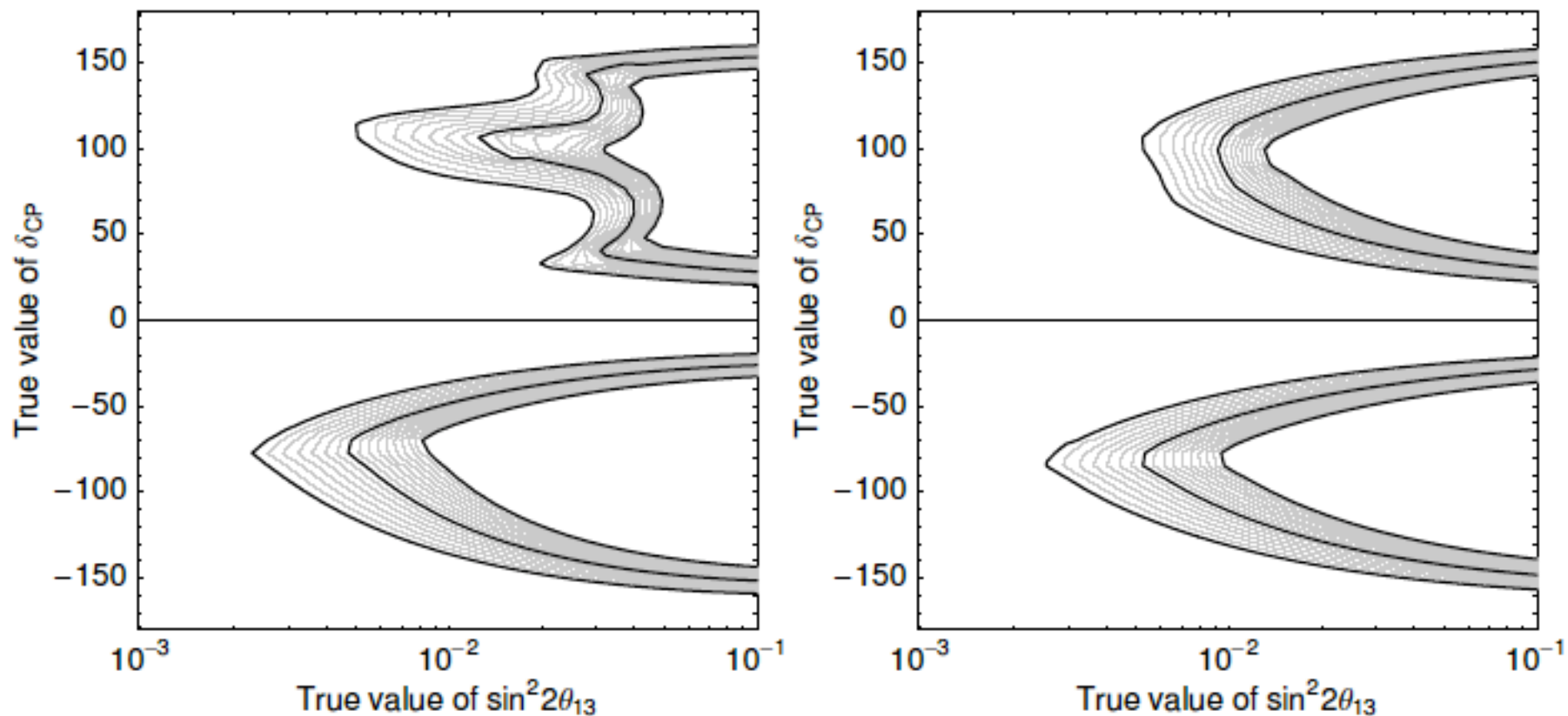


Figure 7: Discovery potential for CP violation at baselines of 730 km (left-hand panel) and 1300 km (right-hand panel). The bold iso- $\chi^2$  lines are 3, 4, 5  $\sigma$  (from left to right) and the light lines show an increase of  $\chi^2$  by 1. For all points to the right of the rightmost bold line, CP violation can be established with at least 5 $\sigma$  significance.

# Points to be made in interim report ?

- ?

# Decisions in 6 months

- Ask for NSF detector R&D funds ~\$2M.  
(sep 27)
- Keep MINOS, Daya Bay, VLBL efforts the same as now.
- Drop MINOS, increase Daya Bay, keep VLBL
- Drop both MINOS and VLBL, just work on Daya Bay.
- What are the implications for BNL and US program? Perhaps we should ask a few wise people: